EFFLUENT WATER QUALITY MONITORING PROGRAM FOR CRANEY ISLAND DREDGED MATERIAL MANAGEMENT AREA

(DACW65-92-R-0001)

Revised Report

March 22, 1995

HAMPTON UNIVERSITY

DEPARTMENT OF MARINE AND ENVIRONMENTAL SCIENCE

AND

DEPARTMENT OF CHEMISTRY

Benjamin Cuker, PhD, Department of Marine and Environmental Science

Isai Urasa, PhD, Department of Chemistry

Wing Leung, PhD, Department of Chemistry

TABLE OF CONTENTS

Objectives

The purpose of this study was to monitor water quality of the effluent from the Craney Island dredge disposal facility. The facility serves as a dredge disposal and dewatering compound for the Hampton Roads area. The facility consists of three cells, each with two sets of pipes that drain from the western side of the compound. Standard operating procedures calls for one cell to be active at a time, generally being used for a period of a year. When not active, the cells continue to shed water as a result of both sediment settling and storm events.

The study was designed to monitor effluent from all cells over the course of a year and to intensely monitor the effluent from an active cell for 1.5 days of operation. The original intent was to do the intense monitoring following a storm event that caused significant flow from the cell. However this had to be altered in response to the drought conditions during the summer of 1993. Instead, the intensive study was done during a period in which the cell was receiving sediment from locations which were suspected of significant contamination. This alternative allowed for monitoring during a "worst case situation."

In addition the study was modified upon the request of the Chief of operations of the facility to include measurements of metals in water released from experimental strip-drains deployed in the north cell. The strip drains provide a capillary pathway for the escape of pressurized ground water, allowing the dredge spoils to settle. The aim is to increase cell capacity for taking additional sediments.

Methodology

Sample Collection

All water samples for laboratory analysis were collected in acid washed containers to avoid contamination from intermediate water sampling devices. Polyethylene bottles were used for all samples, other than metals, which were gathered in glass containers. Samples for metal and organic analysis were preserved with nitric (metals) or sulfuric (organics) acids and stored at 4 C^{O}. A plastic Container was used to collect samples for field analysis.

Samples were collected by placing the bottles in free falling water from the end of the pipes draining the cells whenever possible. During high tides the pipes were submersed so sampling was done from water stream flowing over or through the spill-box

boards. Receiving-water samples were collected off the north shore from the surface layer. Strip-drain water was collected by immersing bottles in the small pools which typically form around each drain.

Field Measurements

Salinity, temperature, pH, and oxygen concentration were measured in the field. A refractometer was used to measure salinity, a YSI temperature-Oxygen meter was used for those parameters, an pH war, measured with a field pH meter. Flow was estimated by either timed filling of graduated containers (effective during low flow) or the weir method (effective during high flows). The weir method was based upon timed movements of water through rectangular sections of the spillbox.

Biotic Measurements

Samples for Chlorophyll-a analysis were filtered through 0.65 um glass fiber filters, frozen, and extracted in 90% buffered acetone. Extracts were analyzed with a spectrophotometer and corrected for phaeopigments by acidification.

Biological Oxygen Demand was determined with a standard 5-day incubation at 20 CO with samples diluted to yield aerobic conditions at the end of the incubation.

Fecal Coliform was tested with the MacConkey Agar method and 24 hour dark incubation at 44.5 Co, followed by enumeration of the colonies.

Suspended Solids and Turbidity

Total Suspended Solids was determined by difference in mass of pre-weighed and dried glass fiber filters. Turbidity was measured directly with a HF turbidity meter (readings in NTU).

Ammonia

Ammonia was determined using a selective probe with the Orion ionanalyzer.

Metals

An Atomic Absorption spectrometer (Spectra AA-20, VARIAN) was used for metal analysis. Calibration was done with ambient salinity solutions.

Oil and Grease

Oil and grease were determined with the partitiongravimetric method, using solvent recovery by distillation.

Organic Compounds

Liquid Chromatography was used with solid phase extraction for isolating organic compounds. Signature peaks were Checked against a computer based library which included data banks for Pesticides, pharmaceuticals, and other organic materials.

Note that all methods conformed to references cited in the Statement of Work.

Sampling Regime

All cells were sampled on a near monthly basis from February 1992 through March 1993. Sampling during some months in the spring and summer was not permitted because of potential disruption of nesting by several species of birds. special samples were taken from the strip-drain field on March 10, and April 30, 1993. The intensive 36 hour study of cell #2 was conducted between July 20 - 22, 1993.

RESULTS

All Cell Monitoring

Stations are numbered 1-6, with station #1 being the first set of pipes draining the cell (#1) closest to land and #6 being the set of pipes draining the cell (#3) at the north end of the island. Station 7 refers to the receiving water.

Estimation of flow - Flow was dependent upon cell filling regime and precipitation events. Estimates are provided in Table 1.

Salinity - Salinity (Table 2) of the drainage water varied with weather and age of sediments. Rain events tended to decrease salinity, while evaporation associated with drier periods tended to increase it. The range of values was typical of natural fluctuations found in the lower Chesapeake Bay.

Temperature - Temperature (Table 3) changes tracked changes tracked typical seasonal trends and were also influenced by the temperature of material being pumped into active cells.

Table 1. ESTIMATED FLOWS DURING SAMPLE COLLECTION FROM CRANEY ISLAND

All Flows are given in liters/second

	DATES							
			1992				1993	
STATION	2/21	3/23	4/13	5/11	7/8	1/29	3/11	4/30
1	6.6	1.4	333.0	15.6	0.4	5.4	1.0	4.1
2	5.7	0.2	5.7	8.4	0.1	0.9	1.2	0.7
3	0.7	2.4	0	0.3	0.1	---	0.3	7.1
4	0.6	---*	25.0	3.6	0.3	2.7	1.1	---
5	0.5	---*	0.5	0	0	0.1	1.4	1.4
6	0.1	0.4	0.1	0.1	0	---	---	---

*incomplete data for these stations

Flows were estimated by one of three methods:
a. timed Collection in graduated receptacle at end of pipe
b. timed flow meter in gate-box with dimensions of box
c. timed surface flow in stream using floating object
Method "all was used in most CASSS. During high flows the libil was used and during low flows when the and of pipes were flooded by a high tide Ilcll was used. Estimates for flow based upon loading of dredge provided by the operations Branch for additional dates are as follows:

	Flow in liters/sec			
Station	10/6/92	10/26/92	11/24/92	12/14/92
1	580	580	0	0
2	580	580	0	0

Table 2. Salinity measurements

SALINITY ppt

STATION	DATES 2/21/92	3/23/92	1/29/93	3/11/93	4/30/93
1	16.0	15.0	15.0	14.0	14.0
2	16.0	15.5	16.0	12.0	13.5
3	19.5	20.0	----	14.0	12.0
4	18.5	19.5	12.0	19.0	----
5	11.0	6.0	13.0	12.0	9.5
6	14.0	5.0	----	----	----
7	18.5	13.0	8.0	5.0	9.0

Table 3. Temperature of Craney Island effluent.

TEMPERATURE C°

STATION	DATES 2/21/92	3/23/92	1/29/93	3/11/93	4/30/93
1	11.8	6.9	8.1	8.9	14.0
2	13.0	9.6	7.6	9.1	14.2
3	10.6	12.8	---	12.2	15.2
4	11.5	16.1	7.1	10.1	----
5	11.5	15.8	7.5	13.2	18.3
6	17.0	15.0	---	----	----
7	11.4	9.0	6.9	8.8	15.8

Oxygen -Dissolved Oxygen levels (Table 4) were always near saturation levels for given salinities.

Table 4. Dissolved oxygen concentrations.

DISSOLVED OXYGEN mg/L

STATION	DATES 2/21/92	3/23/92	1/29/93	3/11/93	4/30/93
1	10.2	9.9	8.9	10.5	8.95
2	10.3	8.3	9.0	10.0	8.50
3	10.6	9.6	---	9.9	11.60
4	6.5	8.3	11.7	11.6	---
5	10.5	7.8	11.3	11.4	11.30
6	13.2	10.6	---	---	---
7	10.3	11.6	12.2	12.1	11.60

PH - The pH (Table 5) varied more than expected for well buffered esturine waters, perhaps reflecting changes in dominant forms of metabolism. During periods of net respiration, PH may have been driven down by release of carbon dioxide and organic acids, while during periods of net photosynthesis the reverse seems to have been operative.

Table 5. The of pH Craney Island drainage.

pH

	DATES				
STATION	2/21/92	3/23/92	1/29/93	3/11/93	4/30/93
1	7.36	7.66	7.6	6.64	7.6
2	7.57	7.60	7.33	7.18	7.7
3	7.17	8.24	---	3.00	7.6
4	7.50	8.83	6.49	4.52	---
5	7.50	8.65	6.67	4.10	7.9
6	7.50	8.6	---	----	---
7	7.80	8.56	6.98	5.00	8.5

Turbidity - Suspended sediments and sometimes phytoplankton rendered the out-falls turbid (Table 6). Highest turbidities seemed to follow rain events on inactive cells when the spill box boards were set low.

Table 6. Turbidity measurements.

TURBIDITY NTU

	DATES				
STATION	F/21/92	3/23/12	1/29/93	3/11/93	4/30/93
1	140.0	1000.0	220.0	120.0	2000.0
2	53.0	500.0	100.0	130.0	1200.0
3	298.0	500.0	---	18.0	320.0
4	220.0	340.0	38.0	45.0	---
5	110.0	320.0	30.0	42.0	160.0
6	11.0	320.0	---	---	---
7	36.0	70.0	14.0	4.0	100.0

Suspended solids-Total suspended solids (Table 7) tracked changes in turbidity.

Table 7. Total suspended solids.

TOTAL SUSPENDED SOLIDS mg/L

STATION	DATES 10/6/92	11/24/92	1/29/93	3/11/93	4/30/93
1	62.3	133.5	0.0	112.0	114.0
2	133.0	222.0	50.0	78.0	105.5
3	60.7	1292.0	---	25.0	62.0
4	59.3	96.5	70.0	35.0	---
5	42.0	68.0	80.0	63.0	72.5
6	---	---	---	---	---
7	90.7	71.5	80.0	27.0	58.0

Chlorophyll - Levels of Chlorophyll-a are given in Table 8.

Table 8. Chlorophyil-a in outfall and receiving waters.

CHLOROPHYLL a mg/L

	1992				1993		
		a	b			DATES	
STATION	10/6	12/14	12/14	1/2	3/10	4/13/93	4/30/93
1	0.006	0.013	0.006	0.013	0.026	0.00	0.00
2	---	0.000	---	0.006	0.00	0.033	0.00
3	0.000	---	0.000	---	.027	0.046	0.006
4	0.000	0.040	0.000	0.000	0.017	0.006	---
5	0.000	0.013	0.013	0.000	0.027	0.006	0.040
6	---	---	---	---	---	---	---
7	0.000	0.040	0.000	---	0.017	0.026	0.046

Fecal Coliform - Analysis of fecal coliform (Table 9) revealed the presence of activity, which is consistent with the active bird populations.

Table 9. Fecal coliform counts based on 100 ml sample.

	FECAL COLIFORM COLONIES / 100 ml DATES	
STATION	1/29/93	3/11/93
1	80	40
2	80	20
3	60	0
4	100	100
5	20	20
6	--	--
7	120	120

BOD - Biological Oxygen Demand (Table 10) from the drainage water exceeded that of the receiving water for about 1/3 of the samples, but most values were within the realm of the receiving waters.

Table 10. Biological Oxygen Demand based upon 5-day incubations.

BOD mg/L

	DATES		
STATION	1/29/93	3/11/93	4/30/93
1	49.8	9.6	6.6
2	13.8	3.0	15.0
3	0.0	6.0	31.8
4	13.2	14.4	---
5	13.2	15.6	29.4
6	45.0	---	---
7	39.0	12.6	8.4

Metals - Values for metals that were below the meaningful level of detection are indicated in the data tables as "ND."

Table 11. Zinc concentration as mg/l (Detectable limit 0.005 mg/l).

	DATES 1992						
STATION	3/23	4/13	5/11	7/8	10/6	10/26	11/24
1	ND	ND	ND	0.015	ND	ND	ND
2	ND	ND	0.006	0.024	0.009	0.658	ND
3	ND	ND	0.008	0.021	0.064	---	0.756
4	ND	ND	ND	0.010	0.023	ND	0.010
5	ND	ND	ND	---	ND	---	ND
6	ND	ND	ND	---	---	ND	---
7	ND	ND	ND	0.006	0.005	---	ND
foam	---	---	0.046	---	---	---	---

ZINC CONTINUED

	1992	1993		
STATION	12/14	1/29	3/10	4/30
1	0.003	ND	ND	ND
2	---	0.003	ND	0.007
3	0.010	---	0.010	0.010
4	0.017	0.010	0.015	---
5	---	0.047	ND	0.011
6	0.044	0.014	---	---
7	0.015	---	---	0.006

Table 12. Iron Concentrations as mg/l (detectable limit 0.04 mg/l).

	DATES					
STATION	3/23/92	4/13/92	5/11/92	7/8/92	10/6/92	10/26/92
1	2.68	0.13	0.148	22.24	0.26	0.46
2	10.73	0.42	0.45	27.86	---	109.01
3	0.23	1.6	3.39	53.06	22.53	---
4	0.36	0.22	0.24	39.99	3.01	0.83
5	0.21	0.81	0.05	---	0.31	---
6	0.07	0.01	0.28	---	---	0.14
7	ND	ND	0.41	0.59	0.93	---
foam	---	---	5.51	---	---	---

Iron Continued

STATION	11/24/92	12/1/92	1/29/93	3/10/93	4/30/93
1	4.69	---	16.32	20.48	---
2	24.86	---	10.20	19.67	10.82
3	13.91	3.06	---	1.21	3.96
4	0.94	0.89	2.93	3.21	---
5	0.37	---	3.11	3.48	3.89
6	---	1.89	0.43	---	---
7	0.24	0.69	---	---	0.81

Table 13. Lead concentrations as mg/l.

	DATE				
STATION	7/8/92	10/6/92	10/26/92	11/24/92	12/14/92
1	ND	ND	ND	ND	ND
2	ND	0.10	0.13	---	---
3	0.003	ND	---	0.13	ND
4	ND,	ND	ND	0.04	ND
5		ND	---	0.05	---
6	---		ND	---	ND
7	0.004	ND	---	ND	ND

Lead continued

STATION	1/29/93	3/10/93	4/30/93
1	ND	ND	0.09
2	ND	ND	ND
3	---	ND	ND
4	ND	ND	---
5	ND	ND	ND
6	ND	---	---
7	---	---	ND

Copper

Table 14. Copper concentrations as mg/l (detectable limit 0.02 mg/1).

	DATE				
STATION	7/8/92	10/6/92	10/26/92	11/24/92	12/14/92
1	ND	ND	ND	ND	ND
2	ND	ND	0.02	ND	---
3	ND	ND	---	0.07	ND
4	ND	ND	ND	ND	ND
5	ND	ND	---	ND	
6	ND	---	ND	ND	
7	ND	ND	---	ND	ND

Copper continued

	DATE		
STATION	1/29/93	3/10/93	4/30/93
1	ND	0.02	ND
2	ND	ND	ND
3	---	ND	ND
4	ND	ND	---
5	ND	ND	ND
6	ND	---	---
7	---	---	ND

Table 15. Cadmium concentrations as mg/l (detectable limit 0.005 mg/1). cadmium levels were always below the detectable limit.

	DATES				
STATION	10/6/92	10/26/92	11/24/92	12/14/92	1/29/93
1	ND	ND	ND	ND	ND
2	ND	ND	ND	---	ND
3	ND	---	ND	ND	---
4	ND	ND	ND	ND	ND
5	ND	---	ND	---	ND
6	---	ND	---	ND	ND
7	ND	---	ND	ND	---

Cadmium continued

	DATES	
STATION	3/10/93	4/30/93
1	ND	ND
2	ND	ND
3	ND	ND
4	ND	---
5	ND	ND
6	---	---
7	---	ND

Table 16. Chromium concentrations as mg/l. Note that Cr detectable limit was 0.05 mg/l and that the high levels of Fe may have interfered with the analysis.

	DATES				
STATION	10/6/92	10/26/92	11/24/92	12/14/92	1/29/93
1	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND
6	ND	ND	ND	ND	ND
7	ND	ND	ND	ND	ND

Chromium continued

STATION	DATES 4/30/93
1	ND
2	0.05
3	ND
4	---
5	ND
6	---
7	0.08

Nickel

Table 17. Nickel concentrations as mg/l (detectable limit 0.03 mg/l.

STATTON	DATES 10/6/92	10/26/92	11/24/92	12/14/92	1/29/93
1	ND	ND	ND	ND	ND
2	ND	0.05	ND	---	ND
3	ND	---	ND	ND	---
4	ND	ND	ND	ND	ND
5	ND	---	ND	---	ND
6	---	ND	---	ND	ND
7	ND	---	ND	ND	---

Nickle continued

STATION	DATES 3/10/93	4/30/93
1	ND	ND
2	ND	ND
3	ND	ND
4	ND	---
5	ND	ND
6	---	---
7	---	ND

Silver

Table 18. Silver concentrations as mg/l (detectable limit 0.04 mg/1)

	DATES				
STATION	10/6/92	10/26/92	11/24/92	12/14/92	1/29/93
1	---	ND	ND	ND	ND
2	---	ND	ND	---	ND
3	ND	---	ND	ND	---
4	ND	ND	ND	ND	ND
5	ND	---	ND	---	ND
6	---	ND	---	ND	ND
7	ND	---	ND	ND	---

Silver continued

	DATES	
STATION	3/10/93	4/30/93
1	ND	ND
2	ND	ND
3	ND	ND
4	ND	---
5	ND	ND
6	---	---
7	---	---

ORGANIC COMPOUNDS

Samples from all stations and the receiving waters were analyzed for 7/8/92 and 10/6/92. A variety of functional groups (N-H, C-H, C=C, 0-H, C-N, C=N) were present in all of the samples, indicating breakdown of larger organic molecules. However, there were no organics present that matched those in the extensive computer based library. Thus, there was no evidence uncovered in this study of contamination by pesticides or other organic pollutants.

Oil and grease - Analysis for Oil and grease revealed the presence of these lipids (Table 19).

Table 19. Concentrations of oil and grease as mg/l.

STATION	5/11/92
1	2304.3
2	0.0
3	233.5
4	1374.8
5	0.0
6	89.7
7	218.0

Ammonia - Ammonia ranged from 0 - 15.8 mg/l (Table 20).

Table 20. Ammonia concentrations as mg/l.

STATION	5/11/92	7/8/92
1	7.15	3.57
2	8.45	10.75
3	7.41	15.80
4	1.13	10.60
5	1.14	---
6	0.00	---
7	0.00	0.95

STRIP-DRAIN POOL ANALYSIS

Table 21. Salinity of strip-drain pools.

	STRIP DRAIN SALINITY ppt DATES	
SAMPLE	3/10/93	4/30/93
D1	19	20
D2	21	25
D3	22	19
D4	16	15
D5	17	21
D6	17	22
D7	14	20
DS	15	21
D9	15	20
D10	21	28
D11	23	25
D12	15	20
D13	15	--
D14	17	--
D15	16	--
D16	16	--
D17	19	--

Zinc

Table 22. Zinc concentrations in strip-drain pools as mg/l.

SAMPLE	3/10/93	4/30/93
DI	---	0.065
D2	---	0.242
D3	---	0.123
D4		0.011
D5	---	0.282
D6		0.290
D7	---	0.017
D8	---	0.139
Dg	0.053	0.015
Dio	0.030	0.038
Dll	1.736	0.019
D12	ND	0.025
D13	0.388	---
D14	0.382	---
D15	0.020	---
D16	0.024	---
D17	0.116	---

Table 23. Iron concentrations in strip-drain pools as mg/l.

SAMPLE	3/10/93	4/30 93
DI	---	9.91
D2	---	---
D3	---	10.88
D4	---	9.18
D5	---	21.19
D6	---	---
D7	---	0.45
D8	---	7.80
D9	8.39	0.85
DID	2.60	1.41
Dll	64.89	4.08
D12	0.39	---
D13	41.47	---
D14	48.43	---
D15	9.20	---
D16	6.76	---
D17	6.84	---

Lead

Table 24. Lead concentrations in strip-drain pools as mg/l.

SAMPLE	3/10/93	4/30/93
D1	---	ND
D2	---	0.14
D3	---	0.07
D4	---	ND
D)5	---	O.40
D6	---	0.07
D7	---	0.07
DS	---	0.19
D9	ND	ND
D10	ND	ND
D11	0.65	ND
D12	ND	ND
D13	0.24	---
D14	0.11	---
D15	0.07	---
D16	0.06	---
D17	0.05	---

Copper

Table 25. Copper concentrations in strip-drain pools as mg/l.

SAMPLE	3/10/93	4/30/93
DI	---	ND
D2	---	0.09
D3	---	0.05
D4	---	ND
DS	---	0.12
D6	---	0.04
D7	---	ND
DS	---	0.04
D9	ND	ND
DIO	0.12	0.03
D11	0.62	ND
D12	0.04	ND
D13	0.08	---
D14	0.09	---
D15	ND	---
D16	0.02	---
D17	0.04	---

Cadmium

Table 26. Cadmium concentrations in strip-drain pools as mg/l.

SAMPLE	3/10/93	4/30/93
D1	---	ND
D2	---	ND
D3	---	ND
D4	---	ND
DS	---	ND
D6	---	ND
D7	---	ND
D8	---	ND
D9	ND	---
D10	ND	---
D11	0.09	---
D12	ND	---
D13	ND	---
D14	ND	---
D15	ND	---
D16	ND	---
D17	ND	---

Chromium

Table 27. Chromium concentrations in strip-drain pools as mg/l.

SAMPLE	4/30/93
D1	ND
D2	0.05
D3	ND
D4	ND
D5	0.05
D6	ND
D7	0.05
D8	---
D9	ND
D10	ND
D11	0.07
D12	---

Nickel

Table 28. Nickel concentrations in strip-drain pools as mg/l.

SAMPLE	3/10/93	4/30/93
D1	---	ND
D2	---	0.03
D3	---	ND
D4	---	ND
D5	---	0.03
D6	---	ND
D7	---	ND
D8	---	ND
D9	ND	ND
D10	ND	0.03
D11	0.12	ND
D12	ND	ND
D13	0.03	---
D14	0.03	---
D15	ND	---
D16	ND	---
D17	ND	---

Table 29. Silver concentrations in strip-drain pools as mg/l.

SAMPLE	3/10/93	4/30/93
D1	---	ND
D2	---	ND
D3	---	ND
D4	---	ND
D5	---	ND
D6	---	ND
D7	---	ND
D8	---	ND
D9	ND	ND
D10	ND	ND
D11	ND	ND
D12	ND	ND
D13	ND	---
D14	ND	---
D15	ND	---
D16	ND	---
D17	ND	---

INTENSIVE STUDY OF CELL #2

Flow, salinity, temperature, oxygen, pH and turbidity

The 36-hour monitoring of cell #2 took place from 9:00 am on July 20 to 19:00 pm on July 21, 1993. All samples were taken from station #4, which was the open spill box at the time. Much of the data is displayed on a time trace graph. Values for the receiving water are displayed in Table 30.

Flow ranged from 625 - 290 liters per second, and appeared to be governed primarily by hydraulic head created from the active pumping of dredge slurry into the cell (fig. 1). Salinity ranged from 18.5 to 25.0 ppt- During most of the first day salinity remained close to 22 ppt and then dropped, following the general pattern for changes in flow (fig 2). Tidal flux at the dredge site may have also had an impact on salinity water masses changing between estuarine and oceanic influence.

Temperature fluctuated between 25.5 and 31.5 C° appearing to track the diurnal change in solar illumination (fig. 3). changes in dissolved oxygen concentration and pH also displayed a diurnal cycle. oxygen levels peaked near noon (9.2 mg/1) on the first day of sampling, but did not climb as high on the second (fig. 4). The pattern was nearly the same for pH, but with a lag of several hours (fig. 5). From this it appears that photosynthesis is important in governing oxygen and carbon dioxide levels in the cell. Oxygen peaks were associated with peaks in solar illumination, which were followed by peaks in pH, an indicator of reduced supply of carbon dioxide, which is consumed during photosynthesis. Swings in pH of this magnitude, especially in well buffered marine systems are associated with highly productive (eutrophic) systems. During the oxygen peaks the concentrations were well above saturation for the temperature and salinity of the water. Such super-saturation is probably due to a combination of intense photosynthesis as well as the effect of warming-up of the cooler bottom waters brought in with the dredge material.

Turbidity ranged from 5 - 39 NTU (fig. 6). Turbidity did not seem very closely linked to flow, suggesting that residence time within the cell during the pumping operation is sufficient for settling of all but the finest particles.

Metals

Tests of the water collected during the 36-hour study of Cell #2 effluent revealed no detectable levels of nickel, copper, chromium, or silver. However, iron (fig. 7), zinc (fig. 8), lead

(fig. 9) and cadmium (fig 10) were all observed.

It should be noted that both lead and cadmium appeared as pulse in the time course, being confined to the first 10-15 hours the study (figs. 9 and 10). This does however caution that water quality of effluent from Craney Island is likely to be quite variable through time.

Table 30. Parameters in receiving water during the intensive study of Cell #2.

	16:20 (7/20/93)	15:30 (7/22/93)
Temperature C°	31.0	29.0
Oxygen mg/l	8.2	8.0
Salinity ppt	16.0	18.0
PH	8.6	8.1
Turbidity NTU	8.0	80.0
Iron mg/l	2.321	7.970
Zinc mg/l	0.033	0.007
Lead mg/l	0.021	0.026
Nickel mg/l	0.0.13	0.000
Copper mg/l	0.025	0.000
Cadmium mg/l	O.000	0.000
Silver mg/l	0.002	0.000
Chromium mg/l	0.000	0.000

ORGANIC COMPOUNDS

None of the samples from the 36-hour study Of Cell #2 revealed the presence of organic pollutants. A variety of functional groups (N-H, C-H, C=C, 0-H, C-N, C=N) were present in all of the samplest indicating breakdown of larger organic molecules. However, there were no organics present that matched those in the extensive computer based library. Thus, there was no evidence of contamination by pesticides or other organic pollutants.

GENERAL CONCLUSIONS

End-of-pipe values for most parameters measured were not high. Moreover, mixing zone dilution would be at least three orders of magnitude on most days and this would most likely bring the discharge to acceptable levels. The greatest potential for exceeding standards would be during periods of high discharge associated with slack tide.

Of the various constituents examined, it appears that lead may present the greatest concern. There was at least one high reading

from each of stations 2, 3, 4 and 5 (Table 13). However, on only two dates (10/6/92 and 10/26/92) were there estimates of substantial flow at stations with the high readings (Table 1). Zinc is the other metal of concern. However, only on one date (10/24/92) was there evidence of high flow (Table 1). To establish the actual impact of lead and zinc upon the receiving waters, it would be necessary to take samples just outside of the mixing zone for each pipe. Also note that neither of these metals, nor any others were high during the intensive 36-hour study (Figs. 8 - 10).

Ammonia concentrations at end of pipe were almost always in excess of the receiving waters (Table 20). This is consistent with the high organic loads anticipated in dredged materials and decomposition of algae and rooted aquatic plants which grow in the cells.

Values for pH (Table 5.) varied more than expected for well buffered marine waters. However, most of the lower readings occurred on 3/11/93. Examining salinity values for that date (Table 2) reveals low readings. Apparently the rainy spring of 1993 diluted both the receiving waters and those of the cells. This would correspond to reduced buffering capacity and hence greater extremes in pH. Also note that this was a period of rising temperatures (Table 3) when decomposition and the associated respiratory processes would accelerate, also causing reduction in pH.

Analysis of the strip-drain-water yielded some high readings for zinc, lead, cadmium, copper, and nickel (Tables 22-26, 28). As will be noted, the values are quite variable. This probably reflects in part the way in which the samples were collected. Since the strip drains weep their capillary flow on the ground there tends to be small pools that collects around each. These pools also collect rain and dust. Since the pools were sampled, rather than harvesting the escaping groundwater directly, this is bound to introduce some variability in the data. Some of the variability may also be natural, reflecting heterogeneity of the ground water, or the layers of sediment through which they penetrate. However, enough of the readings were high to sound a note of caution in proceeding with ground water displacement as a means of increasing the cell sediment handling capacity.

SUMMARY AND GENERAL RECOMMENDATIONS

Some end-of-pipe water quality parameters were high, however dilution in a mixing zone would probably bring levels to permitted levels. Further study that would include samples from outside the mixing zone would be needed to determine the real impact of lead

a9nd zinc. The intensive 36 hour study indicated that water quality during one period of cell loading with dredge material was within legislated levels, but also subject to change in a time frame of several hours. The strip drain samples contained high levels of metals, so this method of increasing cell capacity warrants further study to understand the potential for metal contamination of the cell effluent.

In order to reduce the load of suspended material escaping the cells, they should be operated in such a manner as to maintain a settling pond in front of each weir box. This is also important for inactive cells, since erosion from storm events can generate significant loads of sediment.

Establishing mixing zones for each out-fall and sampling just outside those zones is needed to verify compliance with standards.

Figure 1. Estimation of flow from station #3 during the 36-hour study.

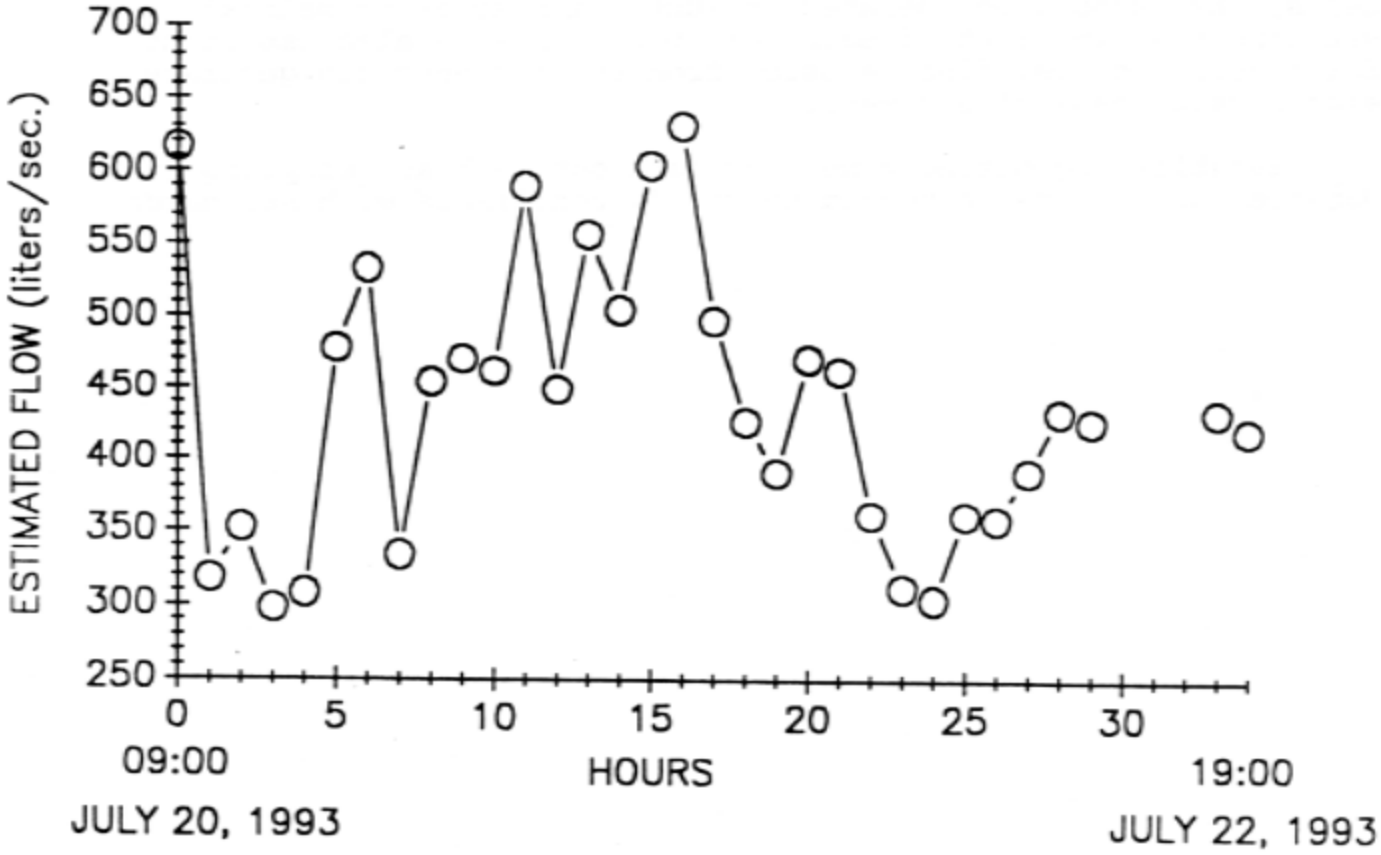

Figure 2. Salinity from station #3 during the 36-hour study.

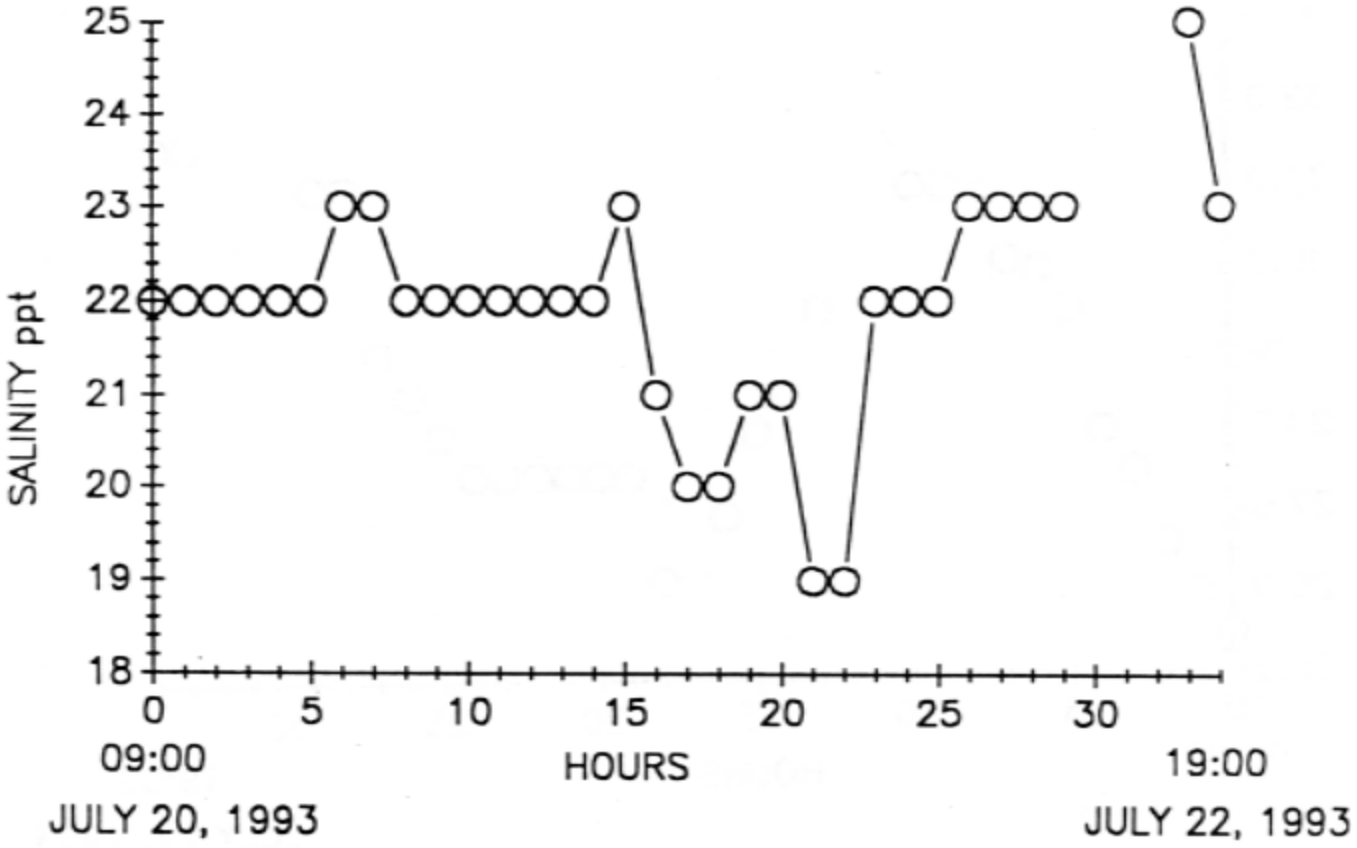

Figure 3. Temperature from station #3 during the 36-hour study.

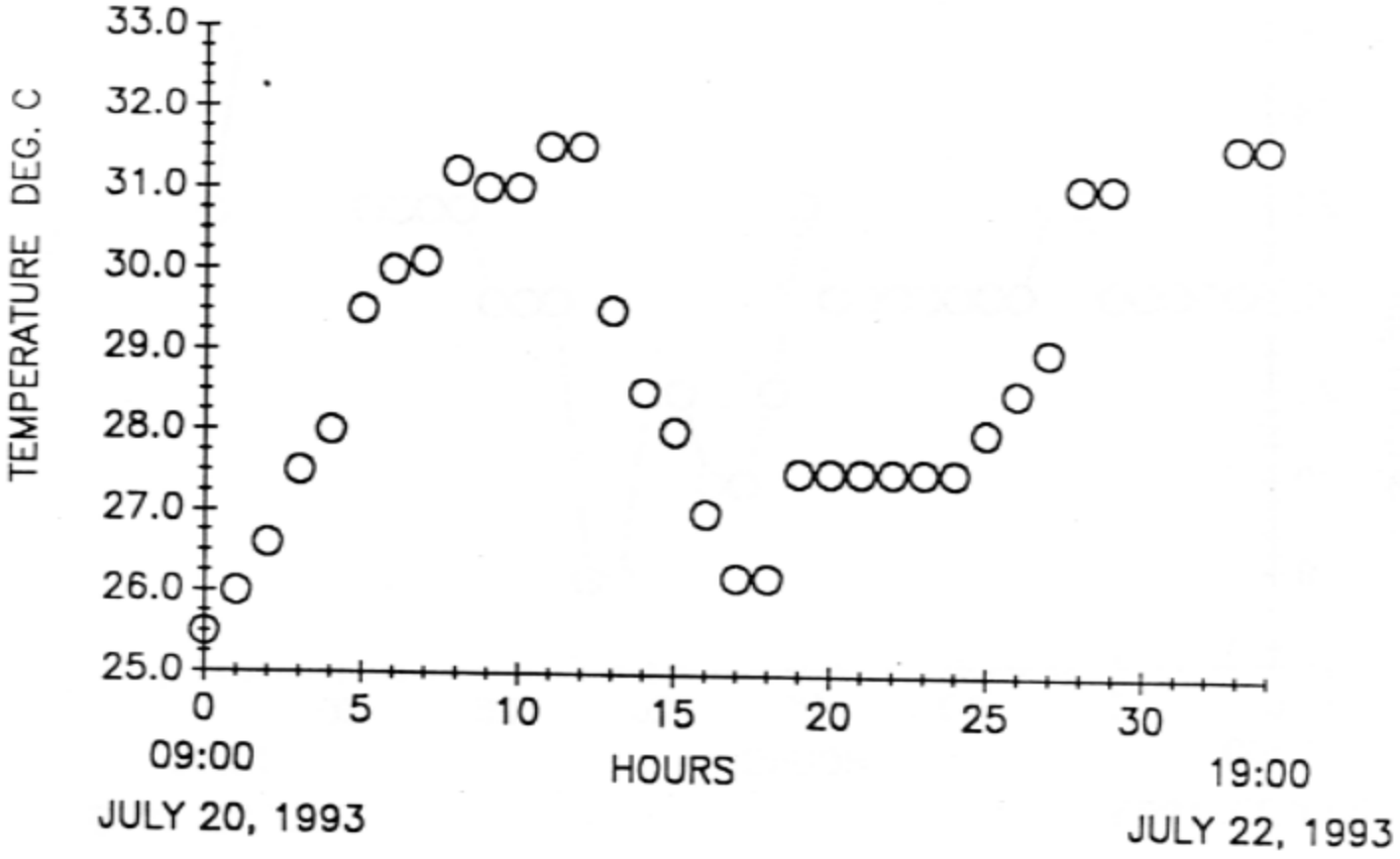

Figure 4. Oxygen concentration from station #3 during the 36-hour study.

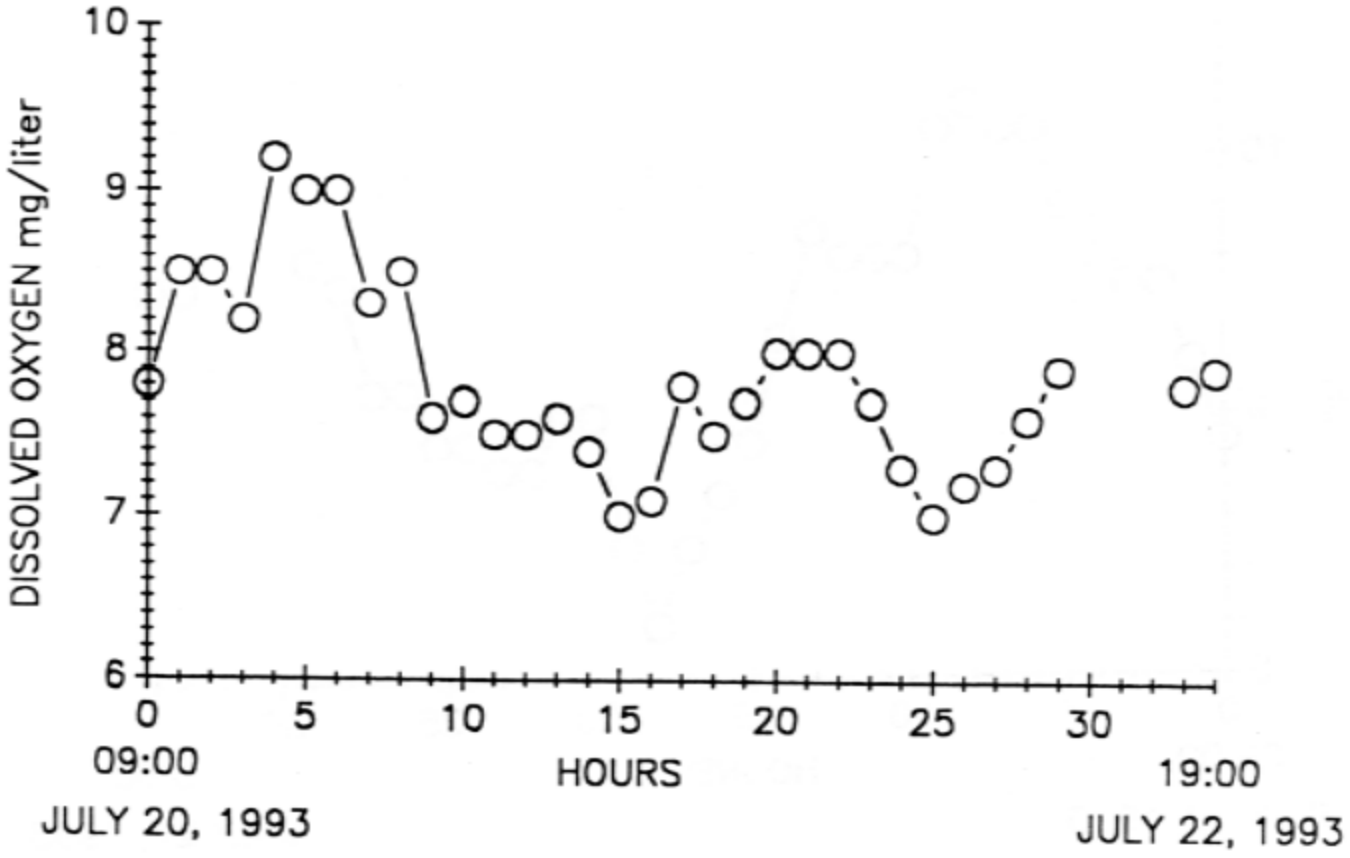

Figure 5. Measurements of pH from station #3 during the 36-hour study.

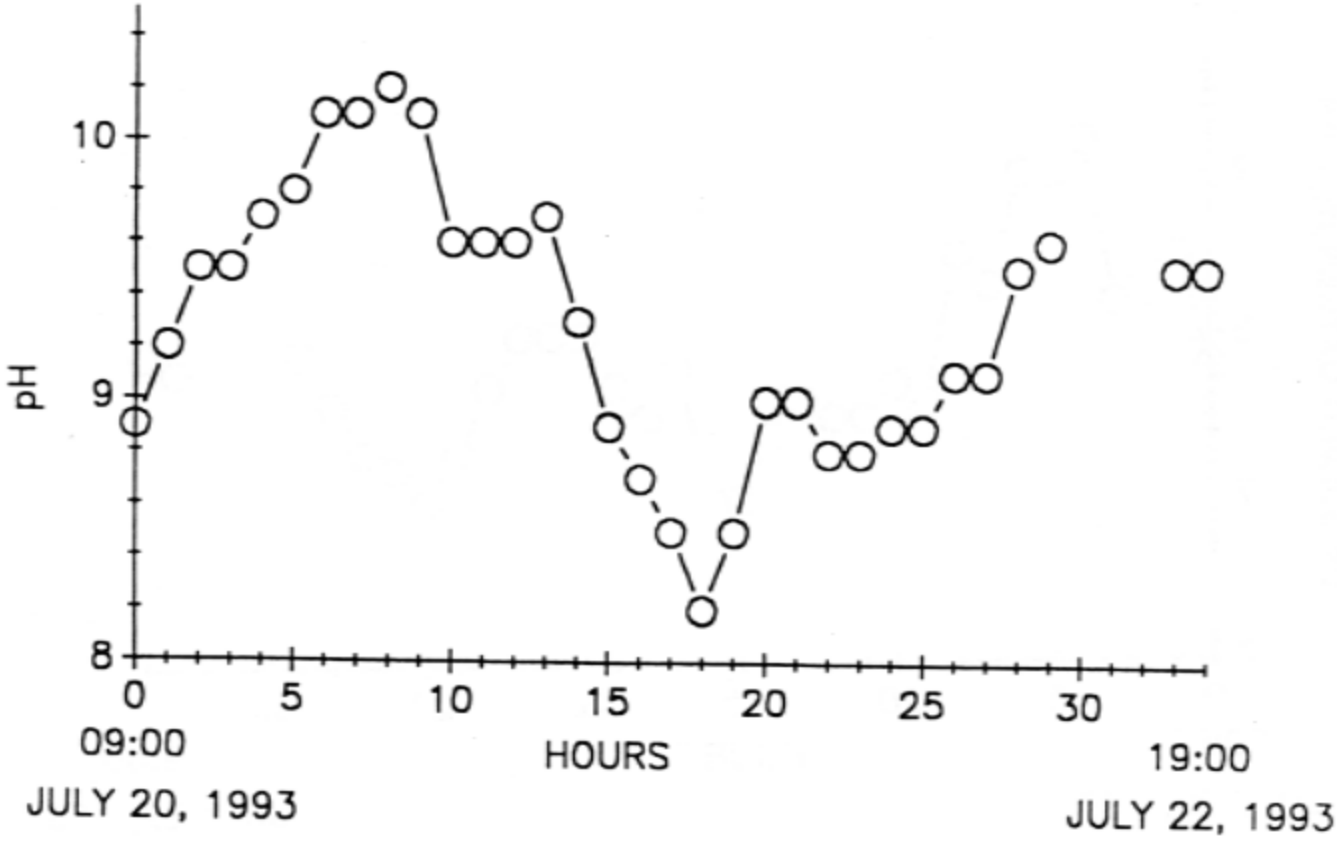

Figure 6. Turbidity (NTU) from station #3 during the 36-hour study.

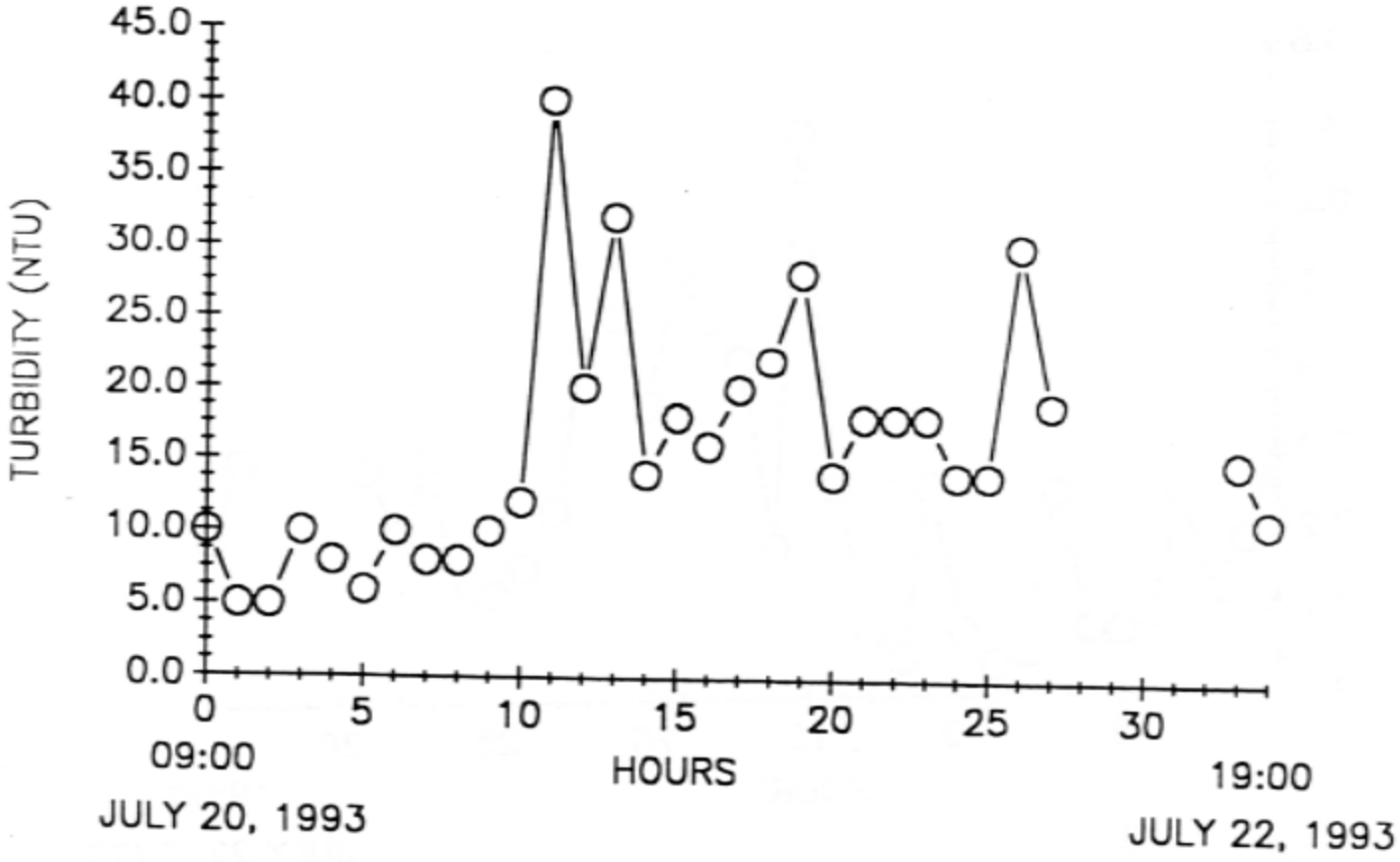

Figure 7. Iron concentrations from station #3 during the 36-hour study.

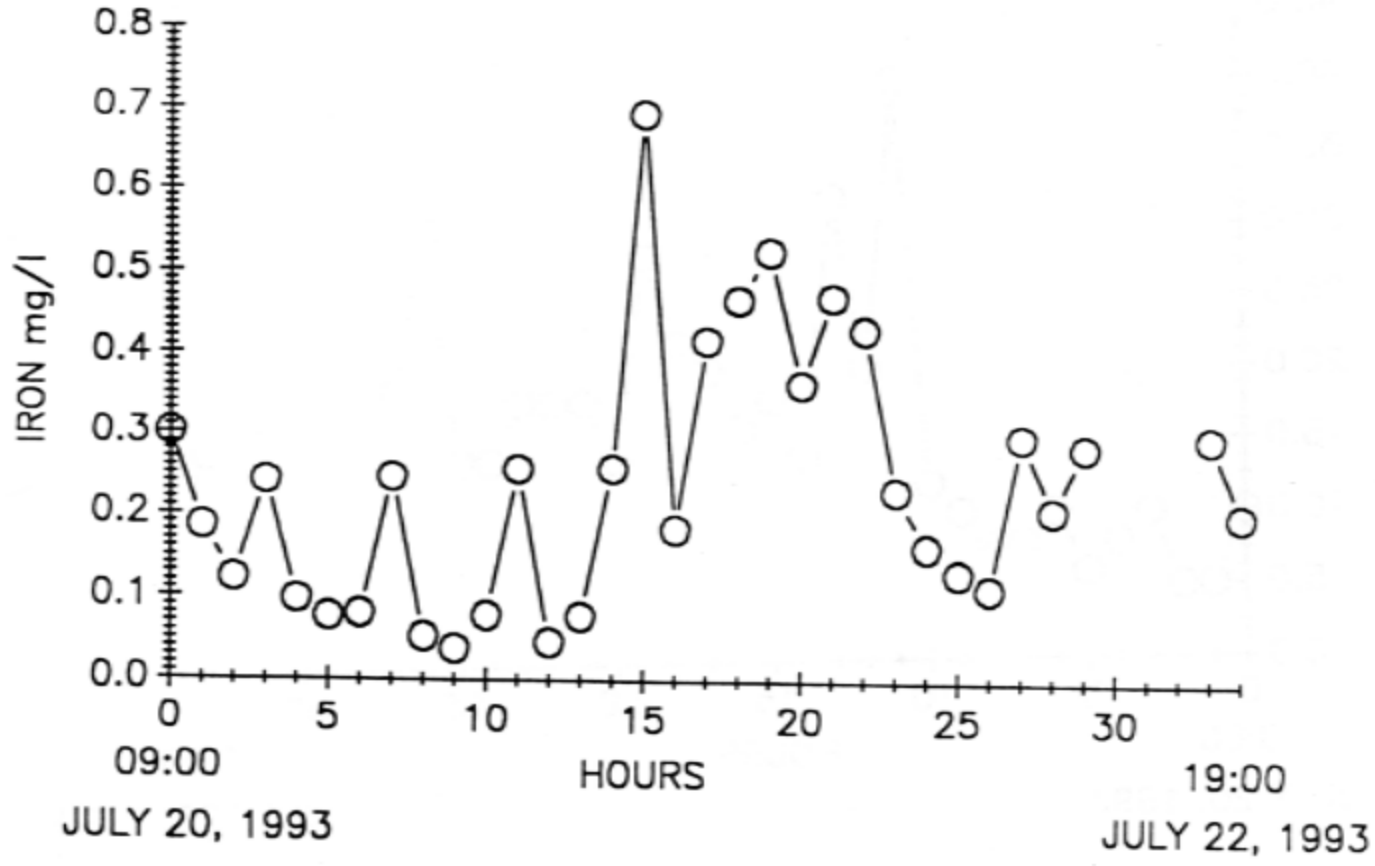

Figure 8. Zinc concentration from station #3 during the 36-hour study.

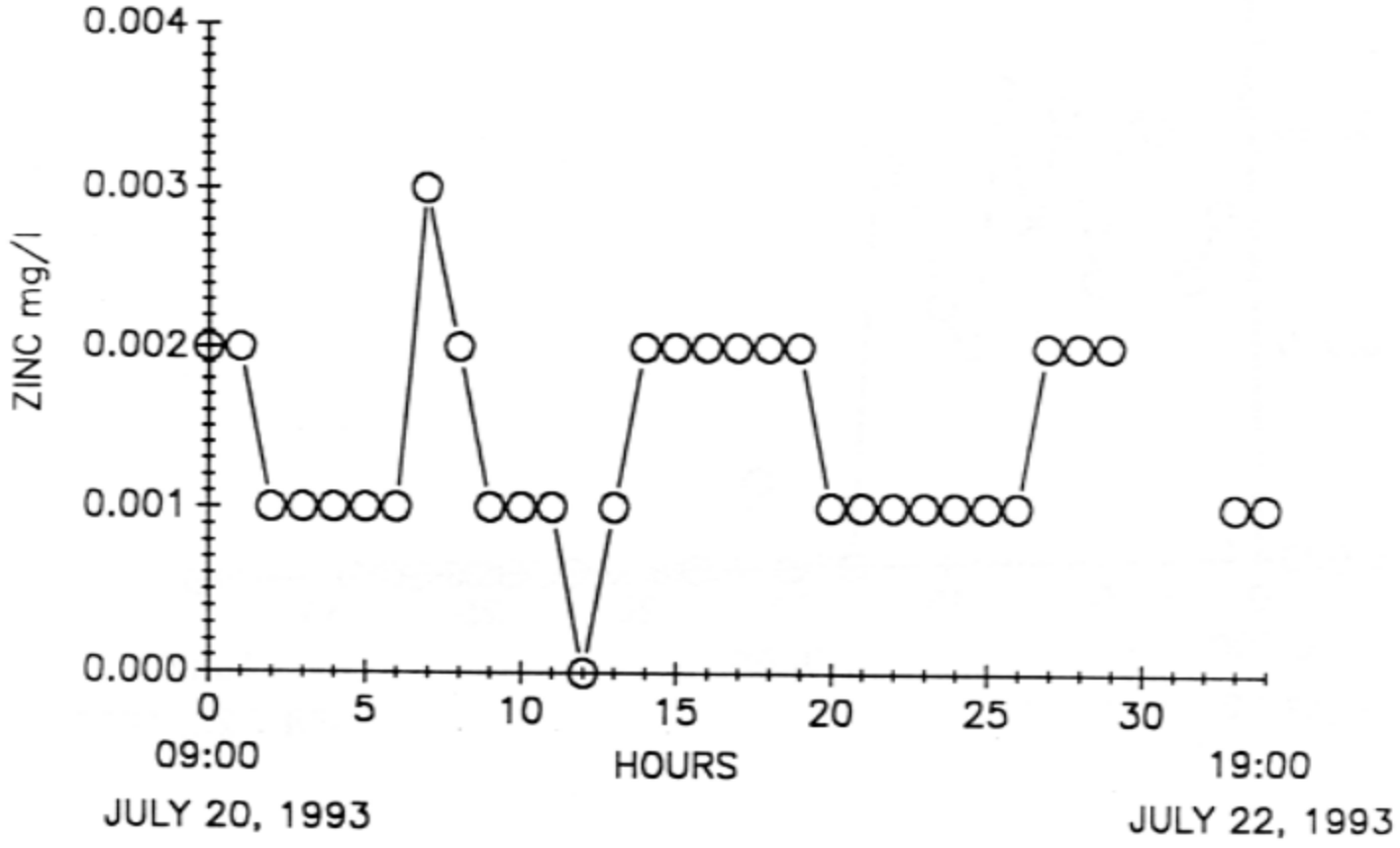

Figure 9. Lead levels from station #3 during the 36-hour study.

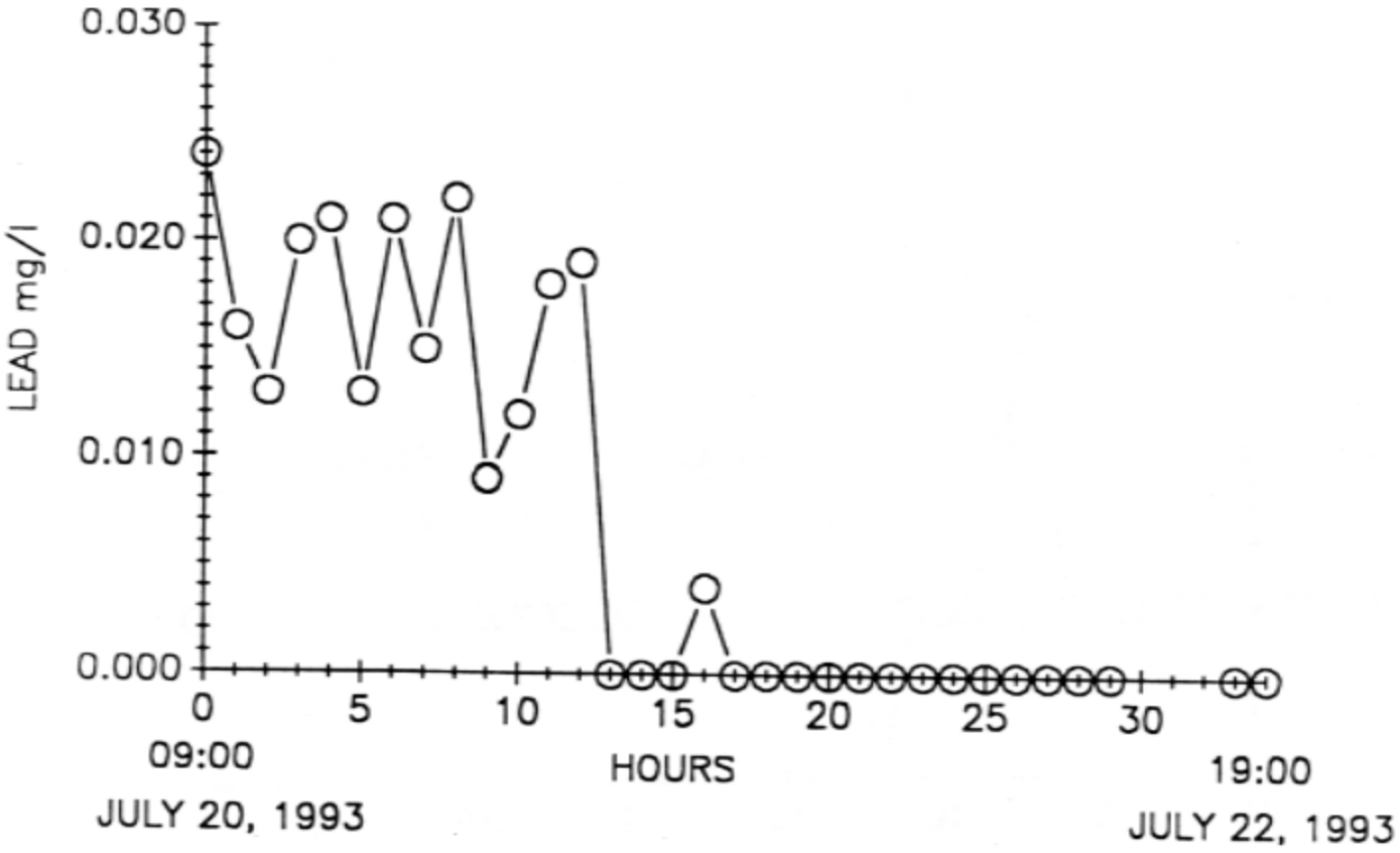

Figure 10. Cadmium levels from station #3 during the 36-hour study.